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ABSTRACT

This report provides a systematic consideration of the use of computers in the schools, including definitions of curriculum, selecting hardware and software, developing materials, and implementing the materials chosen. It is designed for use by school teachers, administrators, and/or school board members who are making decisions about future school district use of computers. A structure for decision making on school district computer implementation is provided, and it is suggested that decision making groups progress step-by-step through the document. The text is supplemented by illustrations and checklists, and a 57-item bibliography of periodicals, newspapers, books and articles. Also provided are lists of microcomputer software evaluation organizations, professional organizations, and sources of assistance. (EW)

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Compilation of Considerations Regarding

The Use of a Computer to Help Teach the School Curriculum

A Joint Project of:
Minnesota Association for Supervision and Curriculum Development
Minnesota Association of School Administrators
Minnesota Department of Education

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Committee Members

This document was developed through the cooperation of the Minnesota Association of School Administrators, Minnesota Association for Supervision and Curriculum Development, the Minnesota Department of Education, and individuals noted for their interest in and knowledge of computers. The document was developed in response to needs identified by the three organizations.

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Introduction

What is the Purpose of this Document?
This document is designed to be used by any school person (teacher, administrator, school board member) in a position to make decisions for a district about the future use of computers. It illustrates a systematic way of defining curriculum, selecting software, selecting hardware, developing materials, and then implementing the materials chosen. This document will serve as a guide for making informed and logical computer decisions.

As many professional staff members as possible should be included in the decision making. The process outlined in this document lends itself to the committee approach.

This document is not intended to be the final authority on computer decisions. It is intended to serve as a structure from which a district can draw conclusions and make final decisions that are appropriate for that district's individual needs. In addition to the decision-making structure, this document contains numerous references and resources where additional help and expertise can be obtained.

How do you use this document?
There are several parts to this document, none of which should be used in isolation or overlooked.

Districts making decisions of this significance should move logically and should progress step by step through the process outlined in this document. Subcommittees may study an individual section; however, every effort must be made to integrate all parts into a whole. Prior to any decisions on hardware, the appropriateness of the curriculum decision must be established. The addition of computers (hardware and software) into a program setting is first and foremost a curricular decision.

The logical decision-making sequence should be as follows:
1. Appropriateness as addition to the curriculum
2. Appropriateness of available software or decision on local development of software
3. Availability of hardware to accomplish the curriculum intent
4. Process for successful implementation into the curriculum

Why was this document produced?
Because of many external factors, including the rapid development of technology, it becomes imperative to provide educational opportunities for students that enable them to fulfill their potential and to adjust to a changing world. A decision to delay until "new technology" is developed, because you believe that what you might purchase now may soon be obsolete, will be a disservice to your students. The basic tenets of computer literacy will remain fairly constant and can readily be adapted to changing technology.

While computers are not a panacea, they do provide alternatives for a school district. They provide options for a labor-intensive budget, and they allow for different strategies in curricular areas, including enrichment, remediation, low-enrollment courses, and so on.

The instructional use of computers must be integrated into the "grand design for instruction" commonly called the curriculum. The reasons to utilize computers are to enhance one's learning and knowledge base. Use of the computer gives the teacher and the learner another tool to accomplish this purpose.

What additional resources are available to help implement the document?
Minnesota is fortunate in that various sources of assistance are available to school districts. Some of these sources and contact people are:

Council of Quality Education (CQE) Computer Project Directors
See listing in bibliography section, or call Sue Sattel: 612-296-5118

Minnesota Educational Computing Consortium (MECC)
Kent Kehrberg, Manager, Instructional Systems Development
Telephone Number: 612-638-0613
Don Rawitsch, Manager, Users Services
Telephone Number: 612-638-0612
2520 Broadway Drive, St. Paul, MN

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Title IV Computer Project Directors
See listing in bibliography section, or call Gayle Anderson: 612-296-5076

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COMMUNITY
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OBJECT

The considerations included in this document are intended to help educators utilize computers in teaching the school curriculum. Underlying all the considerations are two beliefs. The first is that school districts need to use a systems approach to curriculum development and implementation. A systems approach to curriculum considers interacting educational issues or concerns to form an appropriate educational plan. The plan, however, is not static but rather dynamic and continues to be recycled to insure that the plan provides optimum results. Readers are referred to the "Responsive Education" model on page 2. In this section the focus is on general curriculum development and implementation regardless of the subject or delivery system. The second belief is that computers need to be considered as another instructional tool/delivery system, superior in some situations and inferior in others. The intent of this document is to improve instruction and not to promote computer use.

Curriculum in this paper is defined as a written document which is a plan for the education of pupils during their enrollment in school and which will clarify what will be taught, when it will be taught, and in the ways it might be taught. It also improves the teaching process by providing teachers with supports such as assessment and evaluation items, appropriate bibliographies and resources (and, in some cases, with sample activities).

There are numerous reasons for developing a curriculum. Some of the most important are:

1. To clarify for students, staff, and community, the mission of the school and the essentials of the district's total curriculum.

2. To define what learner outcomes/objectives teachers have responsibility/accountability to cover.

3. To define for teachers what learner outcomes or objectives are appropriate for students at different developmental levels.

4. To define how a particular curriculum is to be organized to reduce unproductive repetition and important content voids.

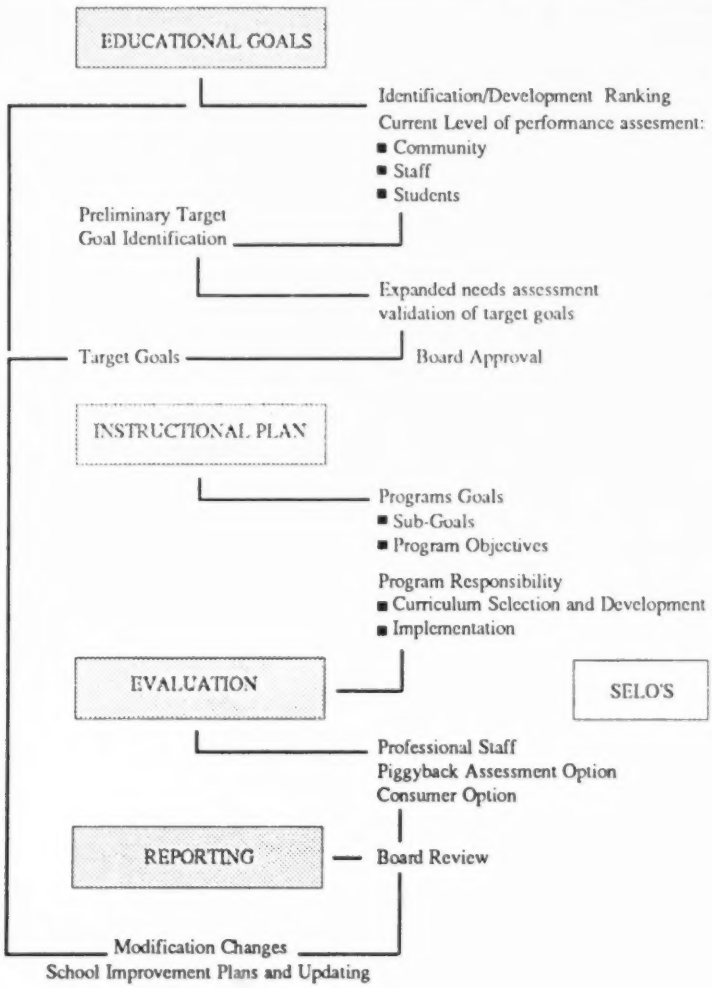
5. To maintain reasonable consistency within a district's offerings so that students are able to receive approximately the same content in various sections of an offering.

6. To establish a common base from which local educators, individually and in a group, can plan for instruction.

7. To identify useful resources that teachers might use to teach specific outcomes and thus enhance the quality of instruction and reduce preparation time.

8. To help integrate learning in the various disciplines.

A curriculum development and implementation system has many formats and designs. The following model has been adapted to practices used in Minnesota. Specifically it has been designed to accommodate the Planning, Evaluation and Reporting (P.E.R.) Law. As the "Responsive Education" model indicates, curriculum development and implementation is perceived within the context of four general headings. Those four headings are: (1) Educational Goals, (2) Instructional Plan, (3) Evaluation, and (4) Reporting. Each of these headings has many elements and requires detailed attention.



Educational goals evolve from an educational philosophy that defines general expectations in different areas of a student's life. Very often school districts use goal formats already developed by organizations and then modify and priortize as is appropriate for them. The Phi Delta Kappa and the Association for Supervision and Curriculum Development goals/subgoals are two sets widely used. It is extremely important to have parent and student participation in the ranking of the goals. Additionally, schools need to consider assessment information derived from tests and other sources of data, such as follow-up studies and questionnaires. In short, great care needs to be given to validating what general expectations there will be for students and educators.

Educational goals, however, provide only general direction. Student learner outcomes on program goals are necessary for determining with more specificity what will be taught (scope), when it will be taught (sequence), and how it will be taught (instructional strategies). These three components are the major elements of an instructional plan. Learner outcomes are usually developed within the framework of a goal or, more often, by subject/discipline areas. Learner outcomes in a well-developed curriculum indicate the concepts students will learn in a given area. They are specific enough so that parents will understand what their children are to learn. Those same learner outcomes are expecially important for determining unproductive duplication and for finding gaps within a subject and among different subjects. Considerable attention needs to be given to insuring that cognitive, attitude, and skill outcomes are specified for each major concept and that the curriculum has balance, relevance, and unity. Educators should also consider whether their curriculum accommodates different learning styles and motivation preferences. Additionally, developers need to be certain that all levels in a learning taxonomy are covered and that there is not an over-reliance on recognition and recall of facts.

Evaluation is the third major consideration in a systems approach to education. Evaluation generally has two lines of consideration, program and individual. Program evaluations are concerned with the effectiveness of instruction to a group, while individual evaluation is concerned with the progress of one student. There are two major types of evaluation at the two levels. Formative evaluation is concerned with ongoing events. This type of evaluation is used to make ongoing corrections, modifications, or adjustments as a means of improving the learning effort. Summative evaluation is an overall look at the effort so as to determine whether the individual as well as the program may be characterized as successful. If at all possible, new curriculum development efforts should be pilot-tested so that problems which arise affect only a small group and can be minimized when working with a larger population.

Reporting is the fourth major consideration in a "responsible education system." There should be concern with providing information that is usable to all groups. Parents and students should understand the general process undertaken at each stage, and the conclusions should be noted in language that is not overly technical or heavy in educational jargon. Educators should receive clear information about which program components need to be modified and which are working well. They also should have sufficient information to determine whether all populations are being served adequately.

If a systems approach to curriculum is in place, then computer activities will likely be more appropriate elements of the school curriculum. A curriculum system increases the possibility that computer activities, and in fact all activities, are part of a defined educational plan—and not merely unrelated activities, which take time but do not help to accomplish specific goals.

Curriculum Review Checklist
This checklist is appropriate for general curriculum regardless of subject matter or delivery system. In the next section, specific consideration is given to the potential of computer delivered curriculum.

Curriculum will be defined in this paper as a written document that is a plan for the education of pupils during their enrollment in school. Curriculum clarifies what will be taught, when it will be taught and the ways it might be taught, and indicates how people will know whether the educational effort was successful or not.

1. Does the document clarify for students, staff, and community, the mission and elements of a district's total curriculum?

2. Does the document have a process for verifying that what is being offered is important and worthwhile, and that it meets state requirements?

3. Does the document offer a plan that is realistic in light of resources available, and does it offer a good possibility of success?

4. Does the document allow for:
- Assessment of needs
- Planning
- Implementation
- Evaluation
- Reporting to the public

5. Does the document sufficiently provide for:
- Scope
- Sequence
- Instructional strategies

6. Does the document provide for learner outcomes in the domains of:
- Cognition
- Skills
- Attitudes

7. Does the document suggest several approaches to accommodate a variety of learning styles and developmental needs?

8. Does the school or building document fit in adequately with the district curriculum and educational philosophy?

9. Does the document allow for both:
- Formative evaluation
- Summative evaluation

10. Does the document lend itself, as a good systems approach should, to a variety of activities including computer approaches?

Potential Use of the Computer

Computer utilization encompasses activities ranging from simply responding to highly directed programs to developing totally new methods of utilizing computers in very complex, personally developed ways. School districts, eventually, will need to define their understanding and expectations for computer use. The following list is intended to assist you in examining the potential of computers. However, they are potentials, not necessarily options that exist today, or more cost efficient than current techniques.

A. Some Potential Contributions to Students' Goals

Self-Concept: the computer can allow for
- Working at one's own pace, minimizing failure
- Privacy to make mistakes without peer pressure
- Immediate feedback and a second chance

Problem Solving: the computer can allow for
- Use of the computer as a tool for problem solving
- Specific practice in problem-solving skills
- Programming as a direct experience with logical, sequential thinking
- Emphasized searching for relationships and analogies

Access to New Information/Body of Knowledge: the computer can provide
- Data bases and forecasting tools
- Projection techniques
- Materials for self-instruction

Skills Development/Enhancement: the computer can provide
- Drill and practice
- Tutorial instruction
- Simulation
- Decision making
- Assessment

Attitudes/Values: the computer can provide
- Values clarification
- Career guidance
- Experience with new technology

Technology Literacy: the computer provides opportunity to interact with technology in a learning situation.

Exploration, Experimentation, and Curiosity Encouragement: the computer can provide
- "Discovery" experiences with open-ended programs that students can manipulate
- Simulations to extend opportunities for experimentation
- Opportunities for students to make the computer work for them

Independent Learning Encouragement: the computer can provide
- A source of feedback in addition to the teacher
- Clarification of subjective/objective judgment
- Self-paced, interactive instruction.

B. Potential Contributions to Teacher Goals and Learner Outcomes

Instructional Options: Through computer use, some subject content can be enhanced without excess

- Time
- Budget
- Facilities
- Resources

Student Motivation: the Computer can allow

- Creativity
- Curiousity
- Challenge
- Rational thinking skills
- Self-evaluation of learner outcomes
- Enhancement of interaction and participation with learning
- Variety in reinforcement
- Participation

Immediate Feedback/Initial Reinforcement: Learner interaction is visually displayed: can provide

- Constant reinforcement—learner assessment of concepts
- Challenges to student—(branching development) tutorial or accelerated learning principles

Exploration (Self-Directed): The computer can allow teachers to interact independently with new content or learning principles.

Technology Literacy: The computer provides opportunity to interact with technology in a learning situation.

Diagnostic Capabilities: The computer can provide for

- Concise, comprehensive assessment of students' individual needs
- Evaluation/statistical measurements
- Ongoing assessment and branching to appropriate level of instruction

Individualized Instruction: The computer can provide for

- Assessment of individual needs
- Monitoring of student progress
- Nontraditional learning principles
- Accommodating individual learning difficulties (special needs, handicaps, and so on.)
- Alternatives for course make-up or content emphasis-acceleration (for the gifted)

Flexibility of Learning Methods: The computer can provide for

- Variety in reinforcing
- Drill and practice
- Problem-solving
- Simulation (role-playing)
- Tutorial (self-paced) learning
- Discover learning through specific programs

Expansion of Learning Experience: The computer can provide instruction for low incident enrollment subject matter and equality of certain types of instruction among schools and districts.
It can allow for additional courses not normally offered because of limitations that are due to

- Liability
- Budget
- Facility
- Expertise

C. Potential Contributions to Home Goals
Extended Instruction: The computer can allow for

- Sharing with parents
- Uniformity of homework
- Clear indication that objectives have been mastered

Preschool Instruction: The computer allows for

- Use of readiness activities
- Self-directed instruction
- Quick evaluation of strengths and needs
- Sophisticated work for nonreaders
- Sophisticated work for children with undeveloped motor skills

Home-bound Instruction: The computer allows for

- Student participation when injured or ill
- Use of apparatus to enhance interaction
- Reduction of movement

Productive Use of Leisure Time: The computer allows for

- Activities that have learning potential
- Activities that are safe but exciting
- Equality relative to ability
- Ability of physically smaller people to compete with physically larger people
- Relatively inexpensive programs
- High staying power

Self-Improvement: The computer allows for

- Self-paced instruction
- Individualized interest
- Immediate response
- Accelerated use of materials
- Travel requirement reduction
- Prompting and corrective feedback
- Reduction of age bias
- Low incidence courses
- Experiments that might otherwise be hazardous

Post Secondary Instruction: The computer allows for
- Self-paced instruction
- Individualized interest
- Immediate response
- Accelerated use of materials
- Travel requirement reduction
- Age bias reduction
- Low-incidence courses
- Experiments that might otherwise be hazardous

D. Potential Contributions to Management Goals
As class size increases the computer can help teachers
- Store student data
- Do pretesting and posttesting
- Direct student progress through a program
- Prepare class profiles

When expenditures shift from the general fund to the capital fund, a computer can be purchased instead of textbooks or other teaching aids.

Low-incidence course enrollment increases because students can use a computer with minimal assistance.

Subsystem curriculum management can be used to
- Monitor what is being taught
- Gather data on student achievement

Special-need student groups: The computer can provide for
- Development of an individual education plan
- Assessment of student needs

Staff motivation: The computer gives teachers a new teaching tool.

Curriculum consistency: The computer provides
- Uniform instruction
- Protection against accidental omission

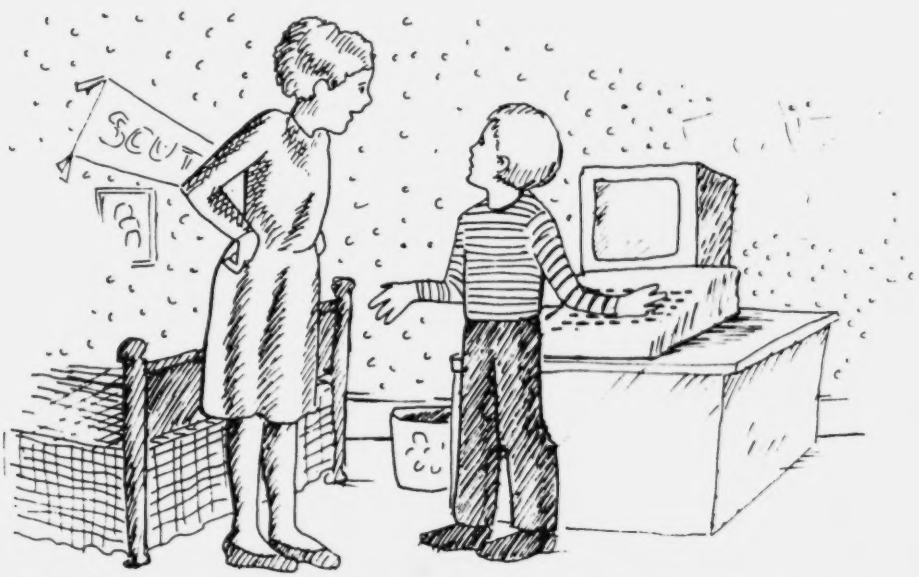
Curriculum record-keeping: The computer allows for
- Gathering data by grade level
- Gathering data by subject areas
- Comparing achievement with potential

Curriculum Efficiency: The computer enables students to
- Can learn some content faster
- Can proceed at a faster pace
- Can experience success

Curriculum system effectiveness increases so that
- Student achievement can be increased
- Objectives can be clarified
- The relevance of content/skills can be learned
- Strengths and weaknesses can be pointed out

E. Contributions that Are Not Possible

A computer cannot replace a teacher's responsibility for diagnosis and prescription.
A computer cannot guarantee that learning will take place.
A computer cannot operate independently, or effectively, without human input.
A computer cannot replace human interaction, either group or individual.
A computer cannot provide adequate auditory or tactile experiences.
A computer cannot <u>care</u> about individual students.



I don't care what it told you, computers do not eat ice cream!

Computer Literacy

The computer is both a tool and a subject of instruction. Schools desiring to teach students to use the computer beyond automatic programs may wish to consider the following concerns as areas for possible study.

Students will be able to discuss and demonstrate:

a. The uses of computers

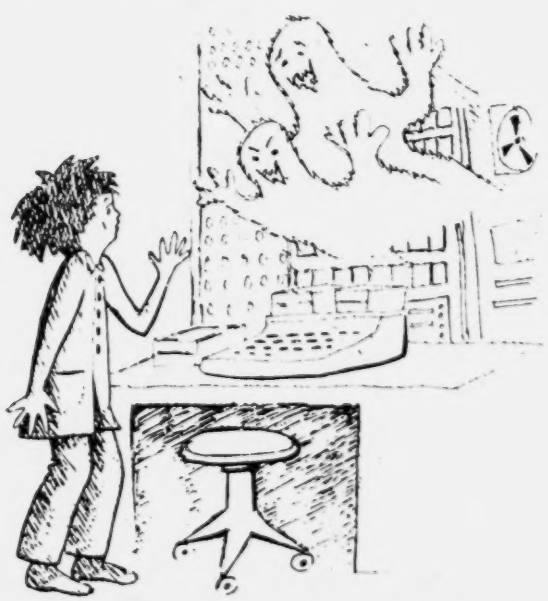
b. The ways computers do their work

c. The theory of programming computers at a basic level

d. Societal implications and limitations of computer use

e. The student should be able to use the computer in some of the following ways:
- To utilize data bases
- To simulate real problems
- To solve problems
- To edit text and perform other word processor functions
- To make decisions
- To convey information in a suitable manner
- To receive instruction

Recognizing the diversity of local schools' needs and priorities, the committee chose not to develop a recommended computer literacy scope and sequence. The committee has located several examples that could serve as models. Readers are encouraged to call the resource people listed on page 44 to obtain the most recent examples.



Section II: Software Selection

Widespread and rapid growth in the number of microcomputers used in Minnesota schools has created a sizable demand for instructional software. This demand is further increased by home users providing educational microcomputer experiences for their children. Private enterprise has responded to these and similar demands with an influx of new software, new companies, and new marketing firms. The marketing firms range from highly reputable to "fly-by-night." Commercial software may range in price from $10 to $895 or more, and the instructinal or technical quality of a program may range from exceptional to poor or inappropriate for classroom use.

In spite of wide quality differences, many educators are hesitant to examine or evaluate software. They feel unqualified because of lack of computer experience or expertise. Although some aspects of this media are new, many are not. Contrary to what some authors of software would have us believe, good instructional design did not originate with the advent of educational computing. "Master" teachers were generating artful, effective lessons and materials long before computers were seriously considered as a potential tool for education. Matching instructional level to reading level, conceptual level to motivational level, and so on (within a single experience or group of experiences), are familiar concerns. An educator wishing to evaulate software should begin with what he or she already knows about evaluating any material or media. One may also wish to use such publications as Handbook for Evaluating and Selecting Curriculum Materials by Meredith Damien Gall (1)* or "Possible Selection Criteria" by Research for Better Schools. (2) Start by learning the unique aspects of computerized materials. A summary of important considerations can be found in the computer software development section of this document. Those wishing more details should look at the original document developed by the Minnesota Educational Computer Consortium (3) and other similarly appropriate materials.

You may also wish to brush up on the elements of instructional design. Principles of Instructional Design by Robert M Gagne and Leslie J. Briggs (4), Curriculum Design and Development by David Pratt (5), and Curriculum Development: A Guide to Practice by Jon Wiles and Joseph Bondi (6) are three of many excellent resources.

Finally, apply common sense and judgment. Don't abandon those practices that have proven successful. Apply standards that promote quality education regardless of media.

Computer Software Selection Checklist
(Note: Combinations of the types of programs listed below are common, so it may be difficult to label some programs as to specific type.)

A. CONTENT—The same considerations apply as for other instructional media.
Overall:
1. Is the content appropriate to your needs? Yes No
2. Does it support your curriculum objectives? Yes No

* More complete references for resources 1-6 are listed in Section VI, Bibliography and Resources.

B. INSTRUCTIONAL DESIGN—Numerous types of programs are available. The following are common examples and some of the concerns of each:

1. Drill and Practice—provides practice for a skill taught previously.
   a. Is there a variety of levels of difficulty? Yes No
   b. Is additional practice provided as needed? Yes No
   c. Does the program provide management feedback—record student performance? Yes No
   d. Are positive and negative feedback given, as well as any necessary hints? Yes No

2. Tutorial—conducts actual instruction, generally in the form of a dialogue between the student and the computer.
   a. Is there an appropriate amount of interaction? Yes No
   b. Is evaluation included? Yes No
   c. Can appropriate segments be accessed by the student without going through the entire sequence? Yes No

3. Simulation—generates models of environments, experiments, and so on.
   a. Is there a reason for using a simulation rather than actual experience (for example, danger or expense)? Yes No
   b. Are opportunities to generalize provided? Yes No
   c. Is graphic representation utilized? Yes No
   d. Are any assumptions identified? Yes No
   e. Is the simulation based on a valid model? Yes No

4. Game—generally includes randomized events, provides an opportunity to "win," and presents some obstacles to "winning."
   a. Is the game appropriate to your needs or objectives? Yes No
   b. Is it instructional as well as diverting? Yes No
   c. Is the student motivated toward learning rather than just winning? Yes No

5. Information Retrieval—Information (data) is generated in the form of lists, graphs, tables, and the like.
   a. Is documentation easy to understand? Yes No
   b. Is storage capacity adequate? Yes No
   c. Is speed of operation or access adequate? Yes No

6. Utility—a support program for the teacher to generate student activities (such as crossword puzzles, word games, individualized spelling or math drills).
   a. Is the utility program flexible? Yes No
   b. Is it easy to use? Yes No
   c. Is it well documented? Yes No

7. Management—record keeping of student performance, which may be an integral part of another program or used alone as a source of diagnosis and prescription.
   a. Is it easy to use? Yes No
   b. Is format suitable for reporting? Yes No
   c. Does it ensure student privacy? Yes No

8. Content—Is the program free of racial/sexual, social stereotypes, inappropriate language, and so on? Yes No

C. Presentation

1. Purpose—Is the intended use—initial instruction, remediation, guided practice, independent practice or enrichment/extension—evident? Yes No

2. Directions—Are they clear to the students? Yes No

3. Objectives—Does the student know what is to be gained by using the program? Yes No

4. Feedback—Is it effective from the students' perspective? Yes No
   a. Does the feedback vary with the performance? Yes No
   b. Does the learner get a correct answer after three or fewer wrong attempts? Yes No
   c. Does the feedback lead to additional learning or merely state "right" or "wrong"? Yes No

5. Display—Is the program visually appealing, attractive, readable? Yes No

6. Ease of use—Can the program be used independently with a minimum of teacher preparation or intervention? Yes No

7. User Control—Does the student have control over rate of presentation? Yes No
   a. Can the student begin the instruction at a level appropriate to his or her ability?
   b. Can the student seek help from the program? Yes No

8. Theoretical Basis—Does the instructional design reflect sound learning theory? Yes No

9. Is the order of presentation logical and sequential? Yes No

10. Have any critical prerequisite skills been identified? Yes No
    a. Is it clear what the student must know or be able to do before using the program? Yes No

11. Intended or Appropriate Audience
    a. Is it clear for whom the program was designed? Yes No
    b. Is it clear for whom it is appropriate? Yes No

D. TECHNICAL DESIGN

1. Is the program "error free"? Yes No

2. Does the program make effective, purposeful use of color, graphics, and sound, or are they used just for "show"? Yes No

3. Does the program adequately provide for misspelled words or variations of responses? Yes No

E. SUPPORT MATERIALS

1. Are the objectives of the support materials clearly defined? Yes No
a. Do they match/complement those of the program? Yes No

2. Is it evident whether support materials are optional or required for proper use of the program? Yes No

3. Do the support materials provide the teacher with additional background (such as a bibliography or other resources, sample run of the program)? Yes No

4. Are the student materials effective, attractive, appealing, and useful? Yes No

F. EQUIPMENT—have the following factors been taken into account and found acceptable or available? Yes No

1. Appropriate computer? Yes No
2. Language? Yes No
3. Memory? Yes No
4. Disk or tape? Yes No
5. Special equipment such as a printer, light pen, paddles, or joystick? Yes No

Section III: Computer Hardware Selection

The challenge in selecting a microcomputer system (or any computer system) is to select a combination of programs and equipment that will meet immediate and, preferably, future needs. This selection can best be accomplished by working from a set of clear goals. Currently, goals for microcomputer use will fall into three broad categories:

1. Instructional Use
2. Administrative/Management
3. Software Development

A. If the goal is to maximize the instructional potential of microcomputers, planners might consider the following:
1. How many students are to be served?
2. What subject matter will be taught?
3. What grade levels will be included in use?
4. Will the equipment be used in individual classrooms or in a laboratory?
5. How have computer applications been included in the curriculum?

B. If the goal is to use microcomputers in administrative areas, consider:
1. Will the system be used for word processing?
2. Is inventory management a likely application?
3. Is there a need to maintain budget information on the computer?
4. Is sufficient storage available?

C. Software development is a broad goal, which can include many functions. Among them are original programming in a high-level language, instruction, advanced programming for students and teachers, and development of courses using an authoring language. All of the functions which focus on the computer as the subject of instruction could be included in this area. Considerations include:
1. Is the system expandable and flexible?
2. Can you use different high-level languages, such as, BASIC, FORTRAN, COBOL, PASCAL, LISP, and FORTH?
3. Is documentation available which will provide thorough access to the machine's capabilities?

D. Overall, there are general questions applicable to the three preceding areas.
1. Will the system have to accommodate more than one user at a time?
2. Would a selection that meets needs in all areas marginally be preferable to a mix of hardware that meets specific needs well?

Criteria for Computer Selection
The following are suggested features. No one device will contain all features or meet all criteria. Your use of the computer will determine the relative improtance of each.

1. Cost: Microcomputers generally range from $100 to $5,000 or more for a complete system. The cost most often reflects the memory capabilities, mass storage devices (disc drives), and flexibility of the system.

2. Portability: In assessing portability of a system, the following should be considered:
- Is weight excessive or can a utility cart be employed?
- Are special environmental considerations (humidity, dust, temperature) a problem?
- How many components must be disconnected before moving the system?
- Can the system work reliably when moved frequently?

3. Mainframe Interface: Can the unit be interfaced with available time-sharing systems to function as a smart terminal (through a communication card, serial card, modem)?

4. Keyboard Layout: There are unfortunately no standards for computer keyboards, although most are similar to a typewriter. Among the variations are size, number and placement of keys, and special key functions. Several computer keyboards also include special numeric key locations to be used in calculation activities.

If at least 50 percent of usage will involve calculation activities, a keyboard with an auxiliary numeric key pad should be considered. (Numeric key pads are available as attachments at an approximate cost of $80 to $250, depending upon functions.)

5. Additional Ports: Ports are connections or "plugs" which connect the computer to other equipment, such as numeric key pads, modulators, printers, or paddles. Ports may be referred to as I/O ports or input/output ports. Where are the ports located? How accessible are they? If ports are located in an inconvenient place requiring that the system be constantly dismantled, perhaps another system should be considered.

6. Memory Capacity Considerations
RAM (Random Access Memory) is used for workspace in the computer, for temporary storage of programs, calculations, results. The amount of RAM determines the maximum size of programs the computer can accommodate. The minimum useful RAM is about 8 thousapd characters (8K), while the preferable amount for most applications is from 48K to 64K.

ROM (Read Only Memory) is useful for storing programs that are used frequently such as BASIC language. This memory is generally programmed by the manufacturer into an integrated circuit chip. The program is stored permanently in the chip. The computer can read the memory but cannot change it. Programs in this form are frequently called firmware.

a. Is sufficient RAM provided to operate the software you have chosen?
b. Can RAM be expanded?
c. Are frequently used programs available in ROM?
d. Can ROM be expanded?
e. Are costs for RAM and ROM expansion within reason?

7. Input/Output Devices: In reviewing the input/output devices, one must determine the capability of such devices.

a. What type of printers are compatible with the system?
b. Is a monitor built in or separate?
c. Must a monitor be used or is a standard television adequate?
d. Are disk drives built in or separate?
e. How many disk drives can the system access?
f. Is the system compatible with a hard-disk drive for mass storage capabilities? What provisions are available for hard-disk back-up?
g. What types of other peripherals are compatible with the system? (graphic tablet, synthesizers, light pens, and so on.)
h. Can system be connected to a video tape recorder (VTR) or a video disk player?

8. Video Display: Video displays may be integrated into the computer or attached as a separate unit.

a. How many characters are available per line on video output? (Video display in most cases is either 40 or 80 characters. For word processing and data management, 80 characters are recommended.)
b. What character sets are available? (Size of text, upper and lower case, upper case only, graphics characters.)
c. Is the system capable of displaying low- or high-resolution graphics?
d. Is the system capable of generating color?

9. Sound Generation: In reviewing sound generation qualities, the following criteria should be considered:

a. Are there internal or external speakers with the system?
b. Can additional external speakers of music boards be added to the system easily?
c. Is the tone or pitch range quality adequate for music generation?
d. Can the system be adapted to voice command or generation with auxiliary peripherals?

10. Documentation: Documentation and support services from the manufacturer or distributor are of great importance in making a final selection. In reviewing materials, the following criteria should be considered:

a. Are there sufficient manuals and support materials for the system?
b. Is the content well presented and easily understood?
c. Are diagrams and step-by-step instructions included?
d. Is the manufacturer/distributor willing or able to answer questions on the phone?

11. Servicing: Service and repair of equipment is another vital concern. Overlooking servicing criteria at the time of purchase and can cause some unnecessary hardships later. For this reason, the following should be considered:

a. What type of warranties are available?
b. What do the warranties include—parts, labor, shipping, and so on?
c. Can school district technical staff be trained to service the equipment?
d. Are training sessions available from the manufacturer?
e. Is training included with purchase or is it available at additional cost?

If the computer must be serviced outside the school district, the following should be considered:

a. Is an on-site service contract available? What are the costs and terms?
b. Is the service center local or remote from the district?
c. Are shipping costs covered?
d. What is average turn-around time for repair and delivery?
e. Are replacement parts readily available?
f. Is a loan program available so lost time can be reduced?

After reviewing the criteria for computer selection, the next logical step is to examine video displays and printers.

Peripherals are often more difficult to evaluate and select than computers.

Manufacturers are constantly producing new peripherals, and the number of variations in standard video displays and printers is astounding. In selecting peripherals, one should make sure that the peripherals are compatible with a particular computer selection and provide the features required for special software applications.

Criteria for Video Display Selection

1. Terminology: Video displays generally range from $75 to $1000. The cost generally indicates: size of screen, black/white vs. color, resolution of screen display for text clarity, color, and graphics.

Several types of video displays can be used in computer applications. One source of confusion is the use of the terms video monitor, video display, or video terminal. All refer to a type of video display for a computer, but each has its own special features.

Video Display: The general term that indicates a device to display video signals from a computer system.

Video Monitor: Similar to a television set, but differs from a standard television in that it cannot receive signals over the air.

Video Terminal: A video monitor equipped with a keyboard and logic circuits for display of characters and graphic information.

2. Alternative Displays: A regular black and white television receiver may be used as a video display. Some computers require an external RF (radio frequency) modulator. An RF modulator is a device that costs approximately $40 and is connected to an I/O port in the computer and the antenna terminals of the television. A modulator will temporarily convert a standard television into a computer display. Although an RF modulator is an inexpensive alternative to a black and white or color video monitor, the screen resolution is somewhat distorted with an RF modulator. Text can become blurry and shadowed, causing unnecessary eye-strain to the user. Readability and clarity of text are not as sharp as other video display alternatives. Check to see that radiation levels from the screen are not excessive.

- If a computer application requires the user to read extensive text, a video monitor should be considered. The second most economical alternative is the black-and-white or green-phosphorus screen video monitor. Average cost for a display of this type is approximately $150. Cost will range from $125 to $350 depending on size of screen and resolution characteristics. Green-phosphorus monitors are generally preferred over black and white for their high quality text display, visual clarity, and reduced eye strain.

Color monitors range from $400 to $1000. The average cost is approximately $450, again depending upon resolution characteristics, size of screen, and so forth.

A color monitor provides better high-quality color definition than a regular television receiver. Color monitors are particularly useful in color graphics displays, but they are not recommended for a great deal of text work (such as business applications or word processing) because of color diffusion and text overlap. For this reason color monitors are not well suited to 80-character line display.

3. Flexibility/Portability: If a video display unit is not built into the computer system, consider:

- What is the weight of the video display device?
- What types of video connectors are required?
- What screen sizes are available—9 inches to 25 inches?
- Are handles available for transportation?
- Are auxiliary input and output connections available so additional monitors can be chained to a single computer?

4. Accessibility of Controls: Location of the various video controls should be reviewed.

a. Are the vertical and horizontal controls easily accessible?
b. If controls are located on the rear of the video display, are they clearly marked and easy to adjust? (Several companies require a special tool or screwdriver to adjust controls on the rear panel.)
c. If controls are located on the front of the system, is a special door or cover available to hide controls when not in use?
d. What type of power switch is available? If a pull-on switch is available, is the knob securely fastened?
e. Is a pilot lamp or power-on signal light provided?

Criteria for Printer Selection

There is a bewildering variety of printers on the market, each with different features, speeds, and interface provisions. But for microcomputer use, there are essentially two fundamental methods for creating letter or graphic symbols on paper. Most familiar is the adaptation and development of the method used in high-quality typewriters. Letters are made by a ball or wheel element which strikes ribbon and paper to produce a clear, fully formed character. Less costly is the dot matrix printer, which forms characters with closely spaced dots. While the characters are easily recognizable and sometimes approach the quality of fully formed characters, only a few dot matrix printers are of correspondence quality. Printers cost from $300 to $5000. The letter quality-printer prices begin at about $1600. This price has been gradually coming down and may approach the cost of a quality electric typewriter in the future.

1. Portability: In assessing portability of the printer, the following should be considered:

a. How much does the printer weigh?
b. How big is it?
c. Does it require special environmental considerations (such as protection from humidity and dust)?
d. Can the printer withstand frequent movement or transporting?
e. How many cables must be disconnected before transporting?

2. Computer Interface:

a. What type of computer interface card is needed? Serial or parallel? Special card developed by the printer company?
b. What auxiliary cords are needed for computer connection?

3. Paper: In reviewing printers, consider type of paper, size, and method of paper advance and entry. If the printer is used heavily, the less expensive printer that uses costly thermal paper may result in higher long-term costs than would have resulted if a more expensive printer had been purchased.

a. Does the printer require thermal, sprocket fed, or regular paper?
b. What is the cost of paper (in bulk quantities)?
c. What size of paper is required—40, 80 or 132 column?
d. Can the printer print on pressure sensitive labels?
e. What is the maximum thickness of paper accepted (suggested paper weight)?

4. Friction-fed printers allow the user to print on letterheads, forms, ditto masters, and regular bond paper. This option is helpful for word-processing operations. Such printers are slower than sprocket-fed printers and may cause some inconvenience to the user.

Sprocket-fed (tractor) printers move paper by advancing the printer sprockets into corresponding holes in the paper. This method assures proper alignment. The operation is very fast and, once the printer begins, no user interaction is required. Tear-away edge on the sprocket-fed paper is recommended when the output will be photocopied.

a. Is sprocket feed only provided?
b. Is friction feed only provided?
c. Does the printer accept both friction and sprocket-fed paper? (This type is recommended for the versatility it provides.)
d. How is paper fed into the machine?
- Bottom feed (requires special stand)
- Front or rear feed (front feed convenient for single sheets)
- Automatic paper feed or manual

5. Speed of Printer: Printer speed refers to the number of seconds it takes to print a group of characters. This rate is expressed in characters per second (CPS). Common speeds are 10, 15, 30, 45, 55, 135, and 225 CPS.

In general, dot-matrix printers are faster than letter-quality printers. If letter-quality is not an important factor, a dot-matrix printer is a good choice for fast, efficient, and reliable printing.

6. Character Sets and Fonts: In determining quality of character sets, the following questions should be reviewed.

a. Is character spacing variable or fixed? If variable, what are the spacings?
b. Is the density of dots forming characters low, medium, or high?
c. Are block or double-width characters available?
d. Is there a double-strike feature for emphasis of headings or titles?

A font is an assortment of type all of one size and style. The more fonts available, the more versatile the printer will be. Some available variations are listed below:

a. Upper case
b. Lower case
c. Condensed
d. Double width
e. Reverse (white on black)
f. Roman, or italic, serif or sans serif
g. Block graphics, fine-line graphics
h. Foreign language symbols, mathematical symbols
i. Range of type sizes

Another feature of the higher quality printers is the storage of alternate character sets in ROM (Read Only Memory). Some printers allow the user to define their own character sets.

7. Operator Control: Operator control refers to the functions of the printer that can be specified by the user. All printers have switches that must be set to determine the printer's functions. In reviewing switch controls, consider the following:

a. Where are switches located? (Switches inside the printer force the user to remove covers to change the switch settings. Switches may be located on the back, front, or side. The front- and side-mounted switches are the most convenient for the user.)
b. Is line-spacing selectable?
c. Are selectable margin settings provided?
d. Is font or character set selectable?
e. Are various computer-to-printer communication rates (baud rate) provided?
f. Is an on line/off line indicator switch provided?
g. Is there a self-test function? (Several printers include a self-test function that allows you to test the internal switches you have set in the system.)
h. Can form switch be set? (Lets the user define the top of the paper for print entry for fan-fold, tractor-fed operation.)
i. Does form feed advance paper to next top of form setting automatically?
j. Does line feed allow user to adjust paper automatically one line at a time?
k. Is manual form alignment possible? (Several printers only have automatic alignment features. Manual adjustments enable the user to control paper as in a typewriter.)

Switch operation and function vary among the types of printers available. The more expensive the printer, the more versatile are the switch selection and font characteristics. Another function is the graphics capability of the system. Graphics are often available for printers as an extra cost option. The size of the character matrix determines the quality of the graphics output. A few printer manufacturers have announced the option of color printing for graphic generation or plotting.

Additional considerations for printer selections should be based on adequate documentation and service contracts. Clear and concise documentation is essential to make full use of printer capabilities provided. In reviewing documentation, a quick reference card for printer switch adjustment and function is a welcome extra.

Service contracts should be a major concern of the user. Printers have more mechanical parts than other microcomputer peripherals and may require service before the rest of the system.

Section IV: Software Development

(Based in part on Designing Instructional Computing Materials* available from the Minnesota Educational Computing Consortium).

There is an increasing recognition of the part computers—especially microcomputers—can play in instruction. Although educational software is available from commerical publishers and computer consortiums, many educators have indicated an interest in developing their own courseware, or in designing material suitable for their own classroom use.

Some consideration of existing courseware which could fulfill the identified needs should occur at this point. Commercial software, MECC, TIES, Title IV, and CQE projects are all sources of existing software which could fit the defined needs of educators. TIES and MECC coordinators can assist you in identifying and previewing their courseware. Title IV and CQE microcomputer projects can be identified by the Minnesota Department of Education and contacted individually.

Commercial software is a more difficult source to utilize. It is almost impossible to preview software unless the company has a local distributor who will lend out the materials. Courseware evaluations are available in journals and in compendiums. Journals which regularly review educational courseware are:

The Journal of Courseware Review
Apple Education Fund
20525 Mariani Avenue
Cupertino, CA 95014

Electronic Learning Magazine
Scholastic Inc.
50 West 44th Street
New York, NY 10036

The Computer Teacher
Computing Center
Eastern Oregon State College
La Grande, OR 97850

On Computing
Box 307
Martinsville, NJ 08836

Collections of courseware evaluations done by educators are:

Micro SIFT
300 Southwest 6th Avenue
Portland, OR 97204

MACUL
Larry Smith
Wayne County ISD
P.O. Box 807
Wayne, MI 48184

JEM Reference Manual
Discovery Park
University of Victoria
P.O. Box 1700
Victoria, B.C. Canada V8W 8Y2

* Designing Instructional Computing Materials, 1981, MECC Publications, 2520 Broadway Drive, St. Paul, MN 55113

If suitable materials do not exist and your district decides to undertake development of courseware, you must examine your available resources. Development is an expensive undertaking in terms of time and money. Estimating costs in either of these areas is difficult and will require close attention by the person who will manage the project.

People resources also must be assessed. A development team should include people with expertise in the following areas:

- Management
- Courseware subject matter
- Courseware design
- Programming

The development process should include classroom-teacher testing and evaluation at both the formative and final stages of courseware development. Therefore, classroom teacher availability and interest must be determined.

If these resources—time, money, and people—are available and the "needs assessment" has been completed, you are prepared to begin development and may find the guidelines in the remainder of this section a valuable reference. You should also keep in close touch with your MECC or TIES coordinators, who may prove to be an invaluable resource.

If these resources are lacking, you may want to consider development on a lesser scale using teacher utility programs or authoring systems. Utility programs, such as MECC and TIES have available, will allow you to set up multiple choice, true-false and completion quizzes that your students can do on the computer. Authoring programs, such as PILOT, take more time to learn but allow you to create drill and practice, and tutorial lesson materials, which can contain graphics and feedback and be highly interactive.

Preparation

The first thing to consider when designing and developing computer courseware is that about 70 percent of what needs to be done is very similar to the process required when developing other curriculum materials. Philosophy, values, goals, and learner outcomes must be defined. Characteristics and needs of learners must be assessed. All people involved need to have a clear understanding of who will do it, when it will be done, what resources are available, why it is being done, how they will know when the project has been completed, and how they will be able to judge its success or failure.

Once a specific product has been "legitimitized," curriculum developers need to make clear linkages to the educational goals and learner outcomes they are addressing. Instructional objectives should be sharpened and the specific concepts, skills, processes, and affective expectations selected and/or defined. Developers, ideally, should provide preinstruction and postinstruction assessment items in addition to making suggestions for content and activities. The learning activities should be flexible enough to allow use by learners of different abilities and learning styles. The content and activities should be designed in a manner that does not require unreasonable demands on resources relative to expected benefits.

Computer courseware development does require some difficult considerations. The remainder of this section will be devoted to an examination of those differences.

Development Process

M.D. Roblyer, in an article titled "Instructional Differences," noted that a major reason why "the majority of microcomputer courseware materials currently on the market is not of acceptable instructional quality" is that technical personnel viewed the production process as programming versus the product as applications software. She correctly notes that instructional design of courseware must be the new emphasis. Roblyer believes that there are four major considerations in establishing an instructional design system:

1. Use of a model
2. Emphasis on a written design document
3. A team approach to development
4. Provision for formative evaluation

The MECC Program (DISC and documentation) "Designing Instructional Materials" acknowledges Roblyer's suggestion for overall planning. Their program, however, is intended to assist people with development of individual products. MECC designed its training program around five topics:

a. Analysis
b. Motivation
c. Interaction
d. Screen layout/graphics
e. Testing and evaluation.

A. Analysis
Before embarking on a specific piece of courseware, teachers should analyze in advance the purposes and objectives they wish to achieve, keeping in mind the above-mentioned use of motivation.

Objectives
1. To determine the objectives of the program
2. To determine the sequence of learning by stating the order of skills to be learned
3. To determine the appropriateness of the microcomputer application
4. To determine which of these skills will be presented on the computer and which will be accomplished by other means, such as teacher presentation of support materials
5. To determine the strategy to be used in presentation

The first step in designing a computer application is the selection of the topic and thus the learning objectives. The next step is to consider instructional design. The following checklist should be kept in mind:

1. State objectives.
2. Decide how courseware will be used in the curriculum.
3. State the skills to be presented and in which order.
4. Determine the appropriateness of the microcomputer.
5. Select a strategy.
6. Review the role of support materials and other media.
7. Design lesson.
8. Test and assess the product.

1. State Objectives
After the topic has been selected, the specific objectives to be achieved should be listed. This list will assist the designer to achieve logical sequential steps in the instructional model. And when the list has thus been divided into parts, it will be easier to decide which pieces of the task can be assigned to the computer. Only after the concept has been analyzed should the specific objectives be written out.

2. How Courseware Will Be Used
Like any curriculum material, instructional courseware must fit into the existing curriculum and its total goals. The specificity of the material as well as its appropriateness for a computer are major considerations.

3. Skills To Be Presented
Designer should arrange the skills in the order they are to be learned. Be aware of the prerequisite skills. Put the easier concepts at the beginning to build the student's confidence. And remember that providing varying degrees of difficulty will enhance the student's success and challenges. Concrete examples should be provided before the abstract ones.

4. Determine the Appropriateness of Microcomputer Application

The designer should select an idea that is appropriate, such as experiments that can easily be done in class. Presentation of large quantities of written material would not be an effective use of the computer. Often a screen full of text material might be presented more effectively in printed form. If the material requires students to discuss or share opinions, the microcomputer may not be suitable. At times, however, the microcomputer can serve as an information device to help students in discussion.

The teaching of the topic should gain in effectiveness through the use of the computer. The microcomputer should "add" to the classroom presentation and not replace something that could be done as effectively or cheaper using another method.

Some ways a computer can add to instruction are:

1. Budgetary—being able to have "actual" experience does not always warrant the cost of needed equipment. Many schools cannot afford the expensive equipment needed for studies in nuclear physics, for example.
2. Time related—many experiences require significant time frames which may not be feasible; population studies, for example, are often prohibitively time-consuming.
3. Risk minimizing—real-world experiences that involve danger may not be practical.
4. Situational—many experiences, like managing a business, cannot be experienced first hand, since businesses would not risk losses just to give a student experience in managing profit margins.
5. Repeatability—many times we wish to repeat experiments exactly. Replication is often impossible in real world situations because of the items listed above.

5. Select a Strategy

The designer must select the type of mode to use. The mode will depend partly on the objective to be achieved and how it will fit into the curriculum.

6. Review the Role of Support Materials

In deciding how the computer material will be incorporated in the curriculum, the role of the support material and other media should be reviewed. How much of the material will be presented on the computer? Will the instructions be on the system, provided by the teacher, or provided on paper? The material could be designed to be dependent on the teacher for some explanation or introduction. Too often, the microcomputer is thought of as a device to replace the teacher instead of a tool for the teacher to use in the classroom. Therefore, the designer should consider integrating the two components to strengthen the presentation of the material. Before the computer module is even designed on paper, these components must be considered. A good computer module is one that achieves the objectives it is designed to accomplish and which captures the student's interest.

7. Design Lesson

Once the strategy, sheets, and objectives have been selected, the instructional sequence must be defined. The strategy selected—drill and practice vs. simulation vs. tutorial—will somewhat determine the sequence.

8. Test and Assess

In assessing the product, all the above elements should be kept in mind. In assessing students' performance, it is important to remember that students should know where they stand in relationship to the required learning. This does not necessarily mean that they need a specific "correct" sign or a grade. However, a feeling of mastery of accomplishment is vital to all learning.

B. Motivation

Motivation is probably the most important ingredient in the teaching-learning process. Teachers should be especially concerned with what makes computer material motivating. The purpose of this program is to get the participants to be as creative as possible in developing ideas. Before students can be motivated, the teacher must also have a clear motive.

Research in the field of motivation dealing with computer material was done by Dr. Tom Malone at Xerox Palo Alto Research Center and reported in his "What Makes Things Fun to Learn: A Study of Intrinsically Motivating Computer Games." Dr. Malone divided this into three catagories: challenge, fantasy, and curiosity.

Challenge

Even rich, responsive environments may be unappealing unless they provide an appropriate goal.

1. Obvious Goal. Simple games should provide obvious goals. Usually the more obvious and compelling the goal is, the better.
2. Appropriate Difficulty. A complex environment with built-in goals should be structured so that users can easily generate goals of appropriate difficulty.
3. Fantasy Goals vs. Goals of Skills. The best goals are often fantasy goals (like reaching the moon in a rocket) rather than simply goals of using a skill (like doing arithmetic problems).
4. Performance Feedback Necessary. The players must be able to tell whether they are getting close to the goal.

Uncertain Outcome: A computer game is not challenging if the player is either certain to win or certain to lose. There are four ways to make the outcomes uncertain for players over a wide range of ability levels:

1. Variable Difficulty Level. Games should be playable at different difficulty levels:
   a. Determined automatically by the program according to how well the player does (drill and practice)
   b. Chosen by the player (perhaps with ego-involving labels like "Cadet," "Captain," "Commander")
   c. Determined by the opponents' skill (chess)

2. Multiple Level Goals. Having different levels of goals, players whose outcome is certain at one level of goal may still be challenged by another level of goal. Two features create multiple level goals:
   a. Score-keeping. The score can reflect the number of tries, the number of successes, the resources expended and so on.
   b. Speeded responses. The computer times the responses, thereby making the game more of a challenge.

3. Hidden Information. Many games, especially guessing games, make the outcomes uncertain by hiding information from the player or players and selectively revealing it. This feature seems to provoke curiosity as well as contributing to the challenge of the game.

4. Randomness. A final way of making the outcomes of a game uncertain is to introduce randomness. Many gambling games seem to succeed almost entirely on the basis of this principle, and randomness can be used to heighten interest in many other kinds of games (adventure games).

Fantasy

Fantasies often make computer games more interesting. In general, games that include fantasy show or evoke images of physical objects or social situations. These objects or situations may involve varying degrees of social or physical impossibility, from completely possible (running a lemonade stand in "Lemonade") to completely impossible (moving instantly from one barrier to another in "Chase"). Nonfantasy games involve only abstract symbols.

Curiosity

Curiosity can be built in a student's mind through the use of graphics, audio effects, or feedbacks. Students can be encouraged to try different options.

Informative Feedback. One way of making environments interestingly complex is to make them responsive:

1. Feedback should be surprising. One way to do this is by using randomness.
2. To be educational, feedback should be constructive. The feedback provided should reinforce and correct the students' thinking, not just say, "WRONG."

Audio and Visual Effects.

1. As decoration or to enhance the fantasy. When sound and graphics are used in a program regardless of what the player does, they can be considered merely "decorative." This kind of effect may enhance the initial interest of a game, but might quickly become boring.
2. As reward. When sound or graphics displays are used to reward good performance, they can increase the salience of the goal and thus add to the challenge of the game. The challenge of reaching a goal, however, can sometimes distract people from exercising their curiosity, and so might decrease certain kinds of learning.
3. As a representation system. Perhaps the best use of sound and graphics in computer games is to represent and convey information more effectively than with words or numbers. For instance, the "Darts" game uses a graphic representation system for fractions, and the "Breakout" game signals bounces and misses of the ball with different tones.

One use of the above list of features is simply to suggest additions to existing or planned computer games. Almost no computer games include all the features mentioned above, and it is usually possible to think of ways that any given game could incorporate more of these features. A learning program, of course, could combine the qualities and appeal of commercial games with valid learning results.

C. Interaction

One of the major teaching assets of the computer is its availability for interaction between the student and the medium. This is achieved by questioning, input, and feedback. As early as 1917, it was demonstrated that a student who made active responses during study time increased his/her learning. In computer courseware, it is suggested that there should never be more than three screens of text without an interaction. Among the techniques available to the computer are typed responses; multiple choice selection, including "cursor control" (moving an arrow until it rests on the right answer); return to a previous panel; providing information on request; and many of the other techniques available to a live teacher. The student can control the speed of performance and the teacher can intervene to encourage discussion of concepts presented.

1. Question and Prompting Techniques

This is one of the most important aspects of interaction. If the question is stated in a confusing manner, the chance of the user making a technical error is heightened. Students should not have to guess what the program wants them to do.

2. Input and Error Processing

Input can be a key to the success of the program. If the input and prompting are well designed, error messages should concentrate on the subject area and not the mechanics of input. (Since the computer is limited compared to the teacher, the designer should try to anticipate the type of input and offer various options for receiving it. The program can give more information, refresh memory, or lead a student through a tutorial about the concept as a whole.)

3. Feedback

Appropriate feedback is another essential for successful courseware. Feedback reinforces students' thinking or redirects them to the right answer. It should motivate and challenge the student.

Some general suggestions: As a rule, a response that helps students determine why they are wrong is better than sarcasm or cuteness. Make the reinforcement positive and motivational. Avoid reinforcement that is time-consuming and slows the pace of the program. The feedback for an incorrect response should be content oriented (rewording the question is sometimes appropriate; if not, further hints can be given). If the students are in a drill-and-practice mode, a review of the missed questions at the end of the drill can reinforce learning.

D. Layout and Graphics

The microcomputer requires the designer to adapt text to a television screen. Aesthetic layout of material contributes to appealing, motivating, and educational effects.

Designers should think of themselves as artists creating the most visual and persuasive message possible. The text, above all, should be legible, easy to read, high-lighted, attractively displayed, and well organized.

The medium here is the screen—a frame somewhat analogous to that of a filmstrip or movie. The advantage of the computer over the filmstrip is that animation and the presentation of ideas in segments are possible. In addition, students can interact with the computer.

Designers should know the screen size and capabilities of the microcomputer they are working with. For instance, how many characters of text can be presented in one line, up or down the screen? What kind of detail is available in graphics? How difficult is it to present a certain image on the screen? Could it be done more effectively another way?

A courseware designer should be both an author and an artist. Many of the elements of good computer courseware depend on principles familiar to artists and printers.The appropriate use of space and contrast, the way the human eye travels from left to right and up and down, and so on. In traditional terms, the designer of courseware should recognize:

1. The size of the screen and its most effective visual qualities; the appropriate use of white and black, contrast, and the framing qualities of space. A crowded screen, like unrelieved columns of type, is unappealing.

2. Legibility. Consider spacing and type size, as well as awareness of the age group addressed. Although upper and lower case are generally recognized as most readable, for lower grades short sentences in caps may be more appropriate.

3. Centering. Centering of the title and subheads and indentation of paragraphs make for easier reading. The centering of important facts (combined with boldface, italics, and other attention-getting typography) provides emphasis.

4. Placement. The human eye tends to focus just above the center of the screen. It is bad layout to begin a presentation below the middle. Research shows that students seldom read text below a question. Important information should always be put above the question.

5. Sentence and word breaks. Careful hyphenation of words is important in typed copy and even more important in a computer, which has a tendency to "scroll" or break-up words mechanically (ending one line with a "t" and beginning the next with "hat").

6. Sequence breaks. Placing the text on the screen in small manageable chunks helps the student to absorb meaning.

7. Appropriate reading level. Periodically check the reading level of the material in various approved ways.

8. Emphasis. In addition to spacing, centering, the use of contrast, caps, boldface and italics, other typographic techniques available on the computer include underlining, boxing, framing, and reverse printing (white on black). Remember, however, that over-indulgence in attention-getters defeats their purpose.

9. Variety. For learning purposes variety is essential. One rule of thumb for courseware is that each text screen should be visually different from its predecessor. The eye should be able to detect new information from the layout.

Audio-visual techniques
Beyond the techniques available to print for emphasis and attractiveness, the computer can make use of the assets of the audio-visual media. These include sound, change of speed in presentation of the text, movement and animation, cyclical imagery, and such attention-getters as flashing lights and arrows.

E. Testing and Evaluating
Before testing one's own courseware, it might be well to evaluate some of the commercial products available in order to get a handle on what will be successful or unsuccessful in one's own program. Three well-known products are "Oregon," "Trapezoids," and "Math Invaders."

"Oregon" is a simulation that includes competition, graphics, timed responses, challenge, and a well-designed model. "Trapezoids" is a tutorial which uses graphics and interaction to teach the concept. "Math Invaders" is a game which rewards the students for answering quickly. Its weakness is that there is no penalty for getting the wrong answer. (Students tend to answer fast rather than correctly.) The scoring is based on the game instead of its educational concepts, and it encourages players to win rather than absorb math facts. Before critiquing your own product, it might be worthwhile to redesign "Math Invaders" in order to make it both motivationally and educationally sound.

In testing any computer courseware, three types of evaluation should take place:
1. A technical review of the program
2. Evaluation of its educational concepts
3. Use in classroon setting

Teachers should follow the same steps in evaluating their programs. (If the teacher is designing programs to be marketed, more formal testing procedures are recommended.)

Technical Review
Should evaluate the following: Text layout is attractive; all material is grammatically correct; user can regulate material (press returns).

Test by typing all combinations of anticipated input to see how they will be handled; type unanticipated input; type a ridiculous answer to see if it will be accepted; if more than one question appears on the same screen, answer each one with unanticipated answers.

Educational Review
Check that instructions are logical and clear; text is readable; text is at correct reading level; use of graphics and sound is appropriate; material is presented in a logical order and in correct segment sizes; feedback is appropriate to the lesson; difficulty level is appropriate to the audience; the program as a whole is pedagogically sound.

Classroom Review
Evaluate the following: Package is motivational; has high degree of student interest; program achieves its purpose; information displays are effective; students are able to read the directions and follow the sequence of material; students can operate the program independently (if so designed); program can be easily implemented by the teacher.

Software Development Checklist

A. Software Needs Assessment

1. Have you targeted the group for which the software is to be developed and their unique instructional needs?	Yes	No
2. Have you determined the appropriateness of the microcomputer application?	Yes	No
3. Have you identified the necessary personnel for the development and evaluation teams?	Yes	No
4. Have you set the goals and objectives to be met by the software?	Yes	No
5. Have you determined the sequence of learning to be achieved by stating the order of skills to be achieved?	Yes	No
6. Have you decided which of these skills will be presented on the computer and which will be accomplished by other means?	Yes	No
7. Have you determined the strategy to be used in the presentation so that the requisite objectives will be achieved and so that it will fit into your curriculum?	Yes	No

B. Software Development

1. Have you selected a learning theory model to guide development?	Yes	No
2. Have you reached agreement on learner outcomes?	Yes	No
3. Have you decided on the learning strategies to be used?	Yes	No
4. Have you reviewed the role of support materials, and in what media and by whom they will be presented?	Yes	No
5. Have you defined the instructional sequence? (Remember that the modes selected—drill and practice vs. simulation vs. tutorial—will to some extent determine the sequence.)	Yes	No
6. Have you provided the students with appropriate and varying degrees of difficulty?	Yes	No
7. Have you set design parameters?	Yes	No
8. Have you designed a lesson format?	Yes	No
9. Have you decided on the most appropriate layout and graphics?	Yes	No

10. Have you provided for appropriate interaction?	Yes	No
a. Clear questioning and prompting techniques?	Yes	No
b. Well-designed input and error processing?	Yes	No
c. Feedback which reinforces student learning or redirects them to the correct answer?	Yes	No
11. Have you reviewed the assembly of programs and support materials in a usable package?	Yes	No

C. Software Evaluation

1. Have you developed an ongoing evaluation plan?	Yes	No
2. Have you tested your software with students/teachers prior to implementation?	Yes	No
3. Have you allowed for a technical review to determine that:		
a. Text layout is attractive?	Yes	No
b. All material is grammatically correct?	Yes	No
c. User can regulate material (press returns)?	Yes	No
4. Have you allowed for an educational review to determine that:		
a. Instructions are logical and clear?	Yes	No
b. Test is at correct reading level?	Yes	No
c. Use of graphics and sound is appropriate?	Yes	No
d. Material is presented in a logical order?	Yes	No
e. Material is presented in correct segment sizes?	Yes	No
f. Feedback is appropriate to the lesson?	Yes	No
g. Difficulty level is appropriate to the audience?	Yes	No
h. The program as a whole is pedagogically sound?	Yes	No
5. Have you allowed for a classroom review to determine that:		
a. Package is motivational?	Yes	No
b. Package has high degree of student interest?	Yes	No
c. Program achieves its purpose?	Yes	No
d. Information displays are effective?	Yes	No
e. Students are able to read the directions and follow the sequence of material?	Yes	No
f. Students can operate the program independently (if so designed)?	Yes	No
g. Program can easily be implemented by the teacher?	Yes	No
6. Have you developed a plan for periodic review and revision?	Yes	No

Section V: Implementation and Training

"They don't want to stop for lunch."

Rationale

Planning for the use of a computer to help teach the curriculum is incomplete without some allowance for a phased implementation of the plan and some carefully considered time lines for teacher training. The resistance to change in education has been thoroughly documented in the research. This fact is especially important to consider in the use of technology, for technophobia (fear of technology) is a very real problem. Because we tend to teach as we have been taught, few teachers among the current generation can fully use technology without some additional assistance.

Implementation of technology must be a gradual process. Training a selected group of people first, rather than wholesale building-by-building or subject-area-by subject-area implementation, has many advantages. If these people can be made to feel completely comfortable with the computer, or other technology, they will serve as role models for other teachers. Further, if these key people are part of the planning process, they will feel a greater sense of ownership. What little research has been done in this area, all points to participation as a key ingredient in successful implementation and integration of computers into the curriculum.[1] Upon this initially trained group rests much of the responsibility for eventual implementation by the rest of the faculty.

Limited budgets for the acquisition of hardware and software also speak to the need for gradual implementation. Implementation should begin only in those areas where resources permit. The degree of implementation is determined by the number of computers available and the level of trained staff. Also, because technology will be constantly changing while this implementation process is on-going, the plan must be flexible enough to adapt to necessary changes. Here the key is determining whether the newer technology provides anything which is necessary for successful implementation without seriously undermining the already completed steps in the process. Newer is not always better.

The most important step in the process of implementation is the selection of one key person to whom will be assigned the tasks of training and facilities management. Schools currently using the technology all attest to increased usage if there is a local district resource person. What follows are suggestions as to the role such a person might play in the district, and specific tasks to be considered in training and facilities management.

[1] Ragosta, M. Barriers and Incentives to Computer Use, Project Report for Educational Testing Service.

Teacher Training

Outlined below is a suggested model for training teachers who will be involved with using the computer in the curriculum. The level of training needed depends on the amount of time spent teaching about the computer itself. As the model suggests, training is not considered to be a one-time in-service activity. It must be continuous. As technology continues to evolve so must the knowledge base of the teachers.

Ideally, a computer should be available at any time for a teacher to use. Integration will not be easily accomplished if all training is outside of the normally contracted day. Some combination of in-service activities, release time, and availability of equipment for checkout over weekends or vacations is preferred.

LEVEL 1	FAMILIARITY WITH EQUIPMENT		
Recommended for *all* teachers	Instruction to the microcomputer 1.5 hr.		
LEVEL 2	**FAMILIARITY WITH APPLICATIONS**		
Recommended for *all* teachers	Integrating Computing Into Curriculum and Lesson Planing 2.5 hrs	Instructional Software Evaluation 1 hr.	Instructing a Computer 1hr.
LEVEL 3	**DEVELOPING SOFTWARE**		
Recommended for teachers who will teach about comuters or develop their own courseware	Authoring Utilities	Courseware Design	Computer Programming

Hardware Management and Implementation Strategies

The best-laid plans for using computers have gone awry because someone forgot to count up the number of electrical outlets required for the type of computer to be used. Many planners fail to recognize that different types of computer usage are dependent on varying numbers of computers. The following section attempts to provide some guidelines for suggested ratios and configurations. While these strategies are ideal, not absolutely necessary, they are based on experiences of current users. Many schools can be successful under less than ideal conditions but unrealistic expectations for the environment, or the number of computers, can surely lead to less than ideal usage.

The ratio of computers to individuals is dependent on the type of task assigned. This ideal ratio to aim for is outlined below by application.

	Computers per	Students
Programming	1	2
Drill and Practice	1	1
Tutorial	1	1
Simulation	1	Small Group
Problem Solving	1	Small Group
Information Retrieval	1	Dependent on Application

The physical location of the computer can present difficulties if the environment is not considered. Unlike mainframe computers, microcomputers present few demands, but it is necessary to provide adequate electricity for each machine. Tables for the equipment should accommodate students of various sizes since most computer programs require some use of the keyboard. Carpeting can present a problem if it generates a lot of static electricity during the winter. All of these potential problems can be overcome easily if some thought is given to such needs before the hardware is ordered.

Another important consideration is the most appropriate method for maintaining the equipment. Several options usually exist, ranging from a district technician handling all repairs to contracts with a local firm to provide on-site maintenance within a guaranteed time frame. Someone familiar with the hardware must explore all local options and their feasibility in light of cost, staff availability, and degree of support needed. The number of machines to be maintained usually provides a critical threshold.

Computers are placed in schools today in a variety of configurations. Each strategy has its advantages and disadvantages. The following outline does not suggest that these are mutually exclusive strategies. Any combination may be successful depending on the proposed use in the curriculum.

Computer Lab

Five or more computers located in a resource center. Often includes two or more printers.

This setting lends itself to networking, teaching programming, and individualized instruction in a variety of subject areas simultaneously.

The disadvantages of this strategy include problems with moving students to the lab, scheduling and supervision, and the integration of classroom activity with lab activity.

Media Center
1. Equipment available on a checkout basis like other AV equipment. This lends itself to making the computer maximally available when appropriate as a tool. The disadvantages to this strategy include scheduling and management, allowing too much selectivity in implementation, and increased maintenance.
2. Equipment available in the media center as indicated for the computer lab above. The same advantages and disadvantages apply.

Classroom
Computer(s) located in individual instructional setting.

This arrangement lends itself to enhanced implementation in all areas of the curriculum because the computer is constantly available as a learning station. The disadvantages to this strategy include inefficient scheduling and usage, insufficient number of machines for small group or class activities, distractions to other students, and increased maintenance.

Other Implementation Concerns
Because technology is dynamic, the person assigned primary responsibility for implementation and facilities management must remain open to change. The learning process and the planning process will be continual. Of special concern is the role this person plays in acting as a liaison among between administrators, instructional staff, and the community. Public relations activities should involve the school board and the community whenever possible. Changing technology, many feel, will increase the interdependence of community, school, and industry. Finding ways to work together today will lead to more successful implementation in the future. The key person must be viewed by others as someone familiar with hardware though not a technician, as well as someone familiar with the ever more available software resources. As facilitator, this person plays a key role in encouraging ever increasing means of integrating technology into the curriculum.

Implementation and Training Checklist

Facilities Management

1. Has the environment for the computer(s) been considered?
   Electrical outlets
   Portable carts
   Tables
2. Which configuration, or combination of configurations, best suits the curriculum goals?
3. What procedures and costs are associated with obtaining, storing, and distributing supplies such as diskettes and paper?
4. How will courseware and documentation be mad available to students and staff?
5. What maintenance support for the hardware is supplied by the vendor and what maintenance procedures can be handled by personnel at the school site? What costs are involved with maintenance?

Training

1. How many staff members have used a microcomputer?
2. What additional staff training is necessary to achieve curriculum goals?
3. How will this training be delivered? Who will deliver it?

Implementation

1. In which area(s) do adequate resources exist to begin the implementation process?
2. What are the implementation time lines?
3. How will additional resources (more trained staff or more computers) be supplied as needed in implementation?

Section VI: Bibliography and Research

Computer Technology in the Classroom*

Periodicals
The periodicals noted below are both education and computer related; however, some have education as the major emphasis while others emphasize computers. They are identified as "Educ." and "Comp." depending on their focus.

AEDS Journal, AEDSD Monitor, and AEDS Bulletin
Available from the Association for Educational Data Systems,
1201 Sixteenth Street N.W.
Washington, DC 20036.
Educ.

Book of Apple Computer Software, The
Four hundred pages of annotated reviews of Apple software.
Sections include business, education, utilities, games.
All programs rated on 6 criteria; for example, documentation, ease of use, and so on.
Comp.
Lawndale, CA: The Book Co. Annual.

Computer Classroom
Emphasis is on using sound educational techniques in the classroom.
One year $16.00.
Published by Intentional Educations, Inc.
51 Spring Street
Watertown, MA 02172
Educ.

COMPUTE
A monthly publication with articles on programming and applications for Atari, PET, and Apple users
$20.00.
P.O. Box 5406
Greensboro, NC 27403
Comp.

COMPUTERWORLD
A weekly newspaper published by Computerworld, Inc.
797 Washington Street
Newton, MA 02160
Comp.

Computing Teacher, The
Designed for educators interested in the instructional uses of computers and calculators.
Nine issues.
Published by the Oregon Council for Computer Education, Computing Center, Eastern Oregon State College,
La Grande, OR 97850
Educ.

Creative Computing
Applications and software magazine for home, business, and education.
Evaluations of hardware and software and programming ideas for beginners to advanced.
Twelve issues, $20.00.
P.O. Box 789-M,
Morristown, NJ 07960
Comp.

Datamation
A free monthly periodical.
1801 South LaCienega Blvd.
Los Angeles, CA 90035
Comp.

Electronic Learning
A well written and entertaining magazine that provides information about developments in electronic learning, especially computers.
Eight issues $19.00.
Published by Scholastic Magazine
902 Sylvan Avenue
Englewood Cliffs, NJ 07632
Educ.

Educational Computer
A bi-monthly publication for teachers on using computers, especially microcomputers, in the classroom.
$12.00.
P.O. Box 535
Cupertino, CA 95015
Educ.

Educational Technology
Published by Educational Technology Publications
140 Sylvan Avenue
Englewood Cliffs, NJ 07632
Educ.

Interface Age
A monthly publication on computing for home, classroom, and business applications.
P.O. Box 1234
Dept. CP
Cerritos, CA 90701
Comp.

Journal of Computer-Based Instruction
Published quarterly by the Association for the Development of Computer-based Instructional Systems (ADCIS), this scholarly journal contains articles on theory, research, and utilization of CAI and CMI.
$12.00 for nonmembers.
ADCIS, Computer Center, Western Washington University,
Bellingham, WA 98225
Educ.

MAEDS Journal
Published periodically.
Minnesota Association for Educational Data Systems.
1925 W. County Road B2
St. Paul, MN 55113
Educ.

The Mathematics Teacher and The Arithmetic Teacher
National Council of Teachers of Mathematics.
Published eight times a year at:
1906 Association Drive
Reston, VA 22091
Educ.

Microcomputer Index
Microcomputer Information Services,
2646 El Camino Real #47
Santa Clara, CA 95051
4/year; $22.00.
Also available online through DIALOG Information Services
3460 Hillview Avenue
Palo Alto, CA 94304
as File 233.
Comp.

Microcomputers in Education
QUEUE
5 Chapel Hill Drive
Fairfield, CT 06432
12/year, $15.00.
(Newsletter)

Nibble
Hardware and software tips and techniques, and programs for the intermediate to advanced Apple user.
Eight issues, $17.50.
P.O. Box 325
Lincoln, MA 01773
Comp.

On Computing
Articles on developments in the field of personal computing—use, books, applications, selection.
Published quarterly by McGraw-Hill.
$24.00.
70 Main Street
Peterborough, NH 03458
Comp.

Peelings II
A bi-monthly publication which reviews Apple software—games, utilities, languages, simulations/educational, technical, and others.
Six issues.
$15.00.
945 Brook Circle
Las Cruces, NM 88001
Comp.

Personal Computing
Articles and programs on education, home, and business applications for TRS-80, PET, and Apple users.
Monthly, $14.00.
1050 Commonwealth Avenue
Boston, MA 02215
Comp.

Pursor's Magazine
Articles and reviews of games, utilities, and educational and business software.
For Apple, Atari, and TRS-80 users.
Free copies available to instructors teaching courses for teachers.
Four issues, $12.00.
P.O. Box 466
El Dorado, CA 95623
Special editions available to Apple, Atari, and TRS-80.
$3.00 each.
Comp.

Recreational Computing
Articles and programs for the user of small home computers.
Bi-monthly, $12.00.
Published by People's Computer Company
1263 El Camino Real
Box E
Menlo Park, CA 94025
Comp.

Softalk
A monthly magazine for Apple users—beginning to advanced; covering hardware, software, and applications for home, business, and education.
Free to Apple owners.
Send your serial number to:
Softalk
11021 Magnolia Blvd.
North Hollywood, CA 91601.
Comp.

The Journal—Technological Horizons in Education
Published by Information Synergy,
Reader Service Department
P.O. Box 992
Action, MA 01720
Educ.

* Much of this bibliography was reprinted with permission from a document entitled "Computer Resources" developed by Total Information Education Systems (TIES), Minnesota School District,
Data Processing Joint Board
1925 West County Road
B2
St. Paul, MN 55113

Newsletters

Apple Educators Newsletter
AEN
9525 Lucerne
Ventura, CA 93003

Call A.P.P.L.E.
A club newsletter in magazine format, including hardware and software tips and techniques, programs, and articles.
Nine issues.
Club membership: one-time fee, $25.00; annual dues, $15.00.
304 Main Avenue South
Suite 300
Renton, WA 98055

Contact 6
Published by Apple Computer, Inc.
10260 Bandley Dr.,
Cupertino, CA 95014

Timely TIES Topics
On Instructional Services, Total Information Educational Systems,
Minnesota School District, Data Processing Joint Board,
1025 West County Road B2
St. Paul, MN 55133

Users—The MECC Instructional Computing Newsletter
Published by MECC User Services
2520 Broadway Drive
St. Paul, MN 55133

Books and Articles

Beck, John J. Computer Literacy for Elementary and Secondary Teachers.
Paper presented at Annual Meeting of Texas Assn. for Supervision and Curriculum Development (ED 208 8).

Chambers, J.A. and Bork, A. Computer Assisted Learning in U.S. Secondary/Elementary Schools.
(Research Report No. 80-03.)
Fresno, CA: Center for Information Processing,
California State University, 1980.

Charp, S. "Effectiveness of Computers in Instruction." Raleigh, N.C.
Conference Procedings: The use of computers in secondary schools, April 1980. pp.1-11.

Gagne, Robert M., and Leslie J. Briggs. Principles of Instructional Design (Second Edition).
New York: Holt, Rinehart and Winston, 1974.

Gall, Meredith Damien. Handbook for Evaluating and Selecting Curriculum Materials.
Boston: Allyn & Bacon, 1981.

Hakansson, J., and Roach, L. "A Dozen Apples for the Classroom," Creative Computing, 1979, 5: 52-54.

Hall, E.E. Issues Related to the Implementation of Computers in Classroom: Where to Now? Austin, Texas: The University of Texas, 1981.

Hirshbey, P., and B.L. Trippett. "3 Successful Programs in Computer Literacy."
Instructional Innovator, 126:26–31, September, 1981.

Hunter, B. "Computer Literacy in grades K–8, "Educational Technology System, 10, No. 1: 596, 1981–2.

Designing Instructional Computing Materials.
St. Paul, Minnesota: Minnesota Educational Computing Consortium, 1981.

"Microcomputers," (symposium) Mathematics Teacher, 74:588–9+, November, 1981.

Pratt, David. Curriculum Design and Development. New York: Harcourt Brace Jovanovich, 1981.

Scheingold, K. Issues related to the Implementation of Computer Technologies in Schools: A Cross-sectional Study. Children's Electronic Laboratory Memo No. 1. (A report prepared under contract No. 400-80-0023.) Preliminary report presented to the National Institute of Education Conference on Issues Related to the Implemenation of Computer Technology in Schools, Washington, D.C., February, 1981.

Stevens, D.J. "Computers, Curriculum, and Careful Planning, " Educational Technology, 21:21–4, November, 1981.

Watt, D.H. "Computer Literacy: What Should Schools Do About It? "Instructor, 91:85-7, October, 1981.

Wiles, Jon, and Joseph Bondi. Curriculum Development: A Guide to Practice. Columbus, Ohio: Charles E. Merrill, 1979.

Wilson, K.G. "English Teachers: Keys to Computer Literacy. "English Journal, 70:50–3, September, 1981.

Wright, Annett. Developing Standards and Norms for Computer Literacy. Discussion paper 06/80. (ED 208 847).

Microcomputing Software Evaluation Organizations

Educational Products Information Exchange (EPIE)
Box 620
Stony Brook, NY 11790
Kenneth Komoski, Executive Director

Purpose: EPIE is a nonprofit consumer-supported agency that gathers and disseminates descriptive and analytical information, along with empirical information on performance and effects on learners, about instructional materials, equipment, and systems.

Publications: Microcomputer Courseware/Microprocessor Games. EPIE Materials Report 98/99m, 1981, 54 pp., $25.00.

MicroSIFT, Northwest Regional Educational Laboratory, Computer Technology Program, 300 S.W. Sixth Avenue, Portland, OR 94204; Judith Edwards-Allen Director.

Purpose: MicroSIFT is a National Institute of Education-sponsored clearinghouse for microcomputer instructional software, K–12. It was established to design effective procedures for collection, evaluation, and dissemination of materials and information, and to incorporate a flexible user support and technical assistance component.

Publications: Evaluator's Guide for Microcomputer-based Instructional Packages. 1981, 61 pp. (ERIC Document Reproduction Service, P.O. Box 190, Arlington, VA 22210, ED 206 330, MF-$.91/PC–$5.30)

MicroSIFT News, Volume 1, Number 1, October 1980; Volume 2, Number 1, October 1981.

Foundation for the Advancement of Computer-aided Education, Educational Program Evaluation Centre (EPEC), 20863 Stevens Creek Blvd., Bldg. B-2, Suite A-1, Cupertino, CA 94015; G. Gregory Smith,Executive Director.

Purpose: The Foundation seeks to foster excellence in computer-assisted education and to recognize programs that demonstrate excellence, innovation, and effectiveness in learning environments. EPEC reviews commercially available educational courseware for all major microcomputer systems, regarding uses, content, and educational validity. Reviews are written by recognized computing education authorities with direct experience in the content areas of programs.

Publications: Journal of Courseware Review, P.O. Box 28426, San Jose, CA; $6.95/issue.

Professional Organizations and Sources of Assistance

Professional Organizations—for membership information, inquire at the addresses listed.

National:
Association for Computing Machinery (ACM)
1133 Avenue of the Americas
New York, NY 11036

Membership Fee: $35
Student: $11

ACM Special Interest Group on Computer Uses in Education (SIGCUE)
Association for Computer Machinery
P.O. Box 12105
New York, NY 10249

Membership Fee:
$4 (ACM Member)
$11.50 (Non-ACM Member)
Student:
$2 (ACM Member)

Association for the Development of Computer Based Instructional Systems (ADCIS)
Mrs. Joan Hayes
Computer Center
334 Bond Hall
Western Washington State College
Bellingham, WA 98225

Membership Fee: $20

Affiliated Group:
National Consortium for Computer-Based Musical Instruction (NCCBMI)

Association for Educational Communications and Technology (AECT)
1126 Sixteenth Street, N.W.
Washington, DC 20036

Association for Educational Data Systems (AEDS)
1201 Sixteenth Street, N.W.
Washington, DC 22335

Membership Fee: $25
Student: $10

Hewlett Packard Upper Midwest User's Group
c/o Computer Center
University of Wisconsin
LaCrosse, WI 54601

National Council of Teachers of Mathematics (NCTM)
1906 Association Drive
Reston, VA 22091

Membership Fee: $12
Student: $6

State:
Minnesota Association for Education Data Systems (MAEDS)
1925 W. County Road B2
Roseville, MN 55133

Membership Fee: $10
Student: $3

Minnesota Computer Society (MCS)
P.O. Box 35541
Minneapolis, MN 55435

Membership Fee: $7
Student: $3

Minnesota Council of Teachers of Mathematics (MCTM)
2520 Broadway Drive
Lauderdale, MN 55113

Membership Fee: $5
Student: $1

MECC Users Association (MAU)
2520 Broadway Drive
Lauderdale, MN 55133

Membership Fee: $2

Mini'App'Les (Apple User Group)
13516 Grand Avenue S.
Burnsville, MN 55337

Membership Fee: $10

Minnesota Educational Media Organization (MEMO)
5408 Knox Avenue South
Minneapolis, MN 55419

Minnesota Council on Quality Education and Title IV Computer-Oriented Programs

CQE Projects

"Computer Video"—Osseo Public Schools.
Investigation of curriculum combining video disks and microcomputers for instruction.
Contact: Brian Doyle, Project Director
Osseo Public Schools
317 Second Avenue Northwest
Osseo, MN 55369
(612) 425-4131 extension 414

"Direct Curriculum Support for the Regular Classroom Teacher with Mainstreamed Special Education Students"—Jefferson High School, Bloomington, 9-12. Support Materials for the moderately handicapped.
Contact: Gretchen Durkot, Project Director
Jefferson Senior High
4001 West 102nd Street
Bloomington, MN 55437
(612) 831-4641

"Problem Solving Through Strategy Games"—Olivia Public Schools. Microcomputer use of strategy games to improve problem-solving and thinking skills, including math concepts, for gifted and talented students.
Contact: Fred Nolan, Elementary Principal
Olivia Elementary School
709 South Ninth Street
Olivia, MN 55277
(612) 523-1962

"Recreational Education Alternative Curriculum Techniques (REACT)"—Columbia Heights Public Schools. SELO-based computer programs for physical education.
Contact: Jo Boettcher, Project Director
Marshall University High School
1313 West Fifth Street
Minneapolis, MN 55414
(612) 379-0428

"School Micros"—Ortonville Public Schools. A variety of applications including reading levels, improving writing, and management.
Contact: Curt Johnson, Project Coordinator
Ortonville Public Schools
Box 247
Ortonville, MN 56278
(612) 839-6181

"Academic Equity for Rural Schools"—Littlefork-Big Falls Public Schools. Self-instructional computerized education.
Contact: Roger Nuensinger, Superintendent
A.E.R.S. Project
Independent School District #362
Littlefork, MN 56653

"Changing Health Behavior"—St. Paul Public Schools. Computerized health assessment, records and curriculum.
Contact: Paula Peterson
Department of Public Health
560 Cedar
St. Paul, MN 55101
(612) 292-7741

Title IV Projects
"Automated Special Services Information and Student Tracking ASSIST"—Hopkins Public Schools
Contact: Loren L. Benson
Hopkins Public Schools
1001 State Highway 7
Hopkins, MN 55343
(612) 933-9201

"Computer-Assisted Intelligibly for Retarded Students"—Minneapolis Public Schools. To develop a remedial strategy for teaching individualized word lists to retarded unintelligible students.
Contact: Deanne Magnusson
Special Education Service Center
254 Upton Avenue South
Minneapolis, MN 55405

3. "Computer-Assisted Problem Solving Skill Practice for Elementary Students"—Rochester Public Schools. Exploration of how to develop a problem-solving skills matrix, a game analysis system, and a micro-library of problem-solving software. K–6.
Contact: Donna Stanger
Lincoln Elementary School
903 Center Street
Rochester, MN 55901
(507) 289-3756

"Computer-Assisted Typesetting"—Roseville Public Schools, 10-12. Use of the latest typesetting technology to improve communication skills for all students and, especially, skills for vocational students in printing.
Contact: Rod Tooley
Kellogg Senior High School
15 East County Road B
Little Canada, MN 55066
(612) 488-4201

"Computer-Based Educational Laboratory"—Red Wing Public Schools, K–12. Use of computers for tutorial assistance, drill and practice, skill mastery and enrichment (includes math, language, communications, foreign language, science, social studies, computer literacy).
Contact: Craig R. Olson
525 East Avenue
Red Wing, MN 55066
(612) 388-7181

"Computerized Language Analysis"—Duluth Public Schools, P-12. Use of computers to speed up and improve standardized language tests, analyze samples, and store data to measure student's future program.
Contact: Cheryl Abramson
Central Administration Building
Department of Special Services
Lake Avenue and Second Street
Duluth, MN 55802

"Computer Modifications for the Handicapped"—West Central ECSU, P-12. Modification of existing programs for exceptional children.
Contact: Laurie S. Satre
West Central ECSU
120 South Vine Street
Fergus Falls, MN 56537
(218) 739-3273

"Interdependent Support Service Model - TMR"—Hennepin Technical Center, K–12. Assessment of development of TMR students in communications and motor skills.
Contact: Lois O. Haug
Katherine Curren School
1600 West Excelsior Avenue
Hopkins, MN 55343
(612) 935-7158, extension 232

"Issues in Nutrition"—St Paul Public Schools, 7–12. Use of microcomputer disks for nutrition instruction.
Contact: Kathleen H. Stuart
360 Colborne
St. Paul, MN 55102
(612) 298-5404

"Microcomputer and Media Services"—Cannon Falls Community Schools. Computerization of media service centers.
Contact: Jim Deacon
Cannon Falls Community School
820 East Minnesota Street
Cannon Falls, MN 55009
(507) 263-3331

"Microcomputer Managed Audio Spelling Project"—Central Minnesota ESCU, 1-6. To develop new programs to improve spelling skills, geared specifically toward learning disabled.
Contact: Doris Bower*
Education Administration Building
St. Cloud State University
St. Cloud, MN 56301
(612) 252-9111
* Now at MECC

"Microcomputers in Education"—Robbinsdale Public Schools, K–6. Developing and testing programs to increase student achievement.
Contact: Bill Heck
Robbinsdale Area Schools
1148 Winnetka Avenue North
Minneapolis, MN 55427
(612) 533-2781, extension 291

"Micro-Math-Magic"—Mankato Public Schools, Grade 4. Use of computers to improve fourth grade math skills.
Contact: Gerald D. Hansen
1524 Hoover Drive
North Mankato, MN 56001
(507) 388-5202

"Secondary Basic Skills Development Design"—Duluth Public Schools, 7-8, 10-11. Computer drill in basic skills and record keeping.
Contact: Donna J. Mark
Central High School
800 Central Entrance
Duluth, MN 55811
(218) 722-6343

"Supplementary Computerized Reading and Mathematics"—Morgan Public Schools, K-12. Exploration of ways in which a small rural school can utilize computers, especially on basic skills; to develop software and teach computer literacy.
Contact: Richard R. Quast
Morgan Public Schools
P.O. Box 188
Morgan, MN 56266
(507) 249-3106

"TIME System (Total Information Management and Evaluation"—Hennepin Technical Center. A task analyzed curriculum-based assessment system for trainable mentally retarded.
Contact: TIME Project Director.
Katherine Curren School
1600 West Excelsior Boulevard
Hopkins, MN 55343
(612) 935-7178

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